UDC 666.1.037:666.3.041

MODERN ELECTRIC FURNACES FOR HEAT-TREATMENT OF CERAMIC ARTICLES AND ART GLASS

S. V. Il'in[1] and A. P. Slobodskoi[1]

Translated from *Steklo i Keramika*, No. 5, pp. 35 – 37, May, 2008.

The enterprise "TermIKS" manufactures a new generation of electric furnaces for mollification and fusing of glass as well as for drying and firing ceramic articles. The minimum admissible temperature differential is maintained throughout the entire period of heat treatment of an article in the furnaces.

Heat treatment of glass and ceramics in electric furnaces is an important stage of the technological process, since at this stage the physical – mechanical properties of the material are set and phase transitions and chemical reactions occur. The rates of all these processes depend strongly on temperature. Consequently, it is very important that glass and ceramic articles located in different sections of the working space in an electric furnace be continually at the same temperatures. In other words, the properties and quality of the final product must be consistently high and the temperature distribution in the working space must be highly uniform.

This problem is solved by a corresponding power distribution in different sections of the heating chamber and, when necessary, using several, separately controlled, heating zones. When specialists at the "TermIKS" Scientific and Industrial Enterprise designed electric furnaces for these technological processes, an efficient power distribution was chosen using mathematical and experimental modeling.

[1] "TermIKS" Scientific and Industrial Enterprise, Moscow, Russia.

As a result, in 2006 – 2007 "TermIKS" developed and put into serial production modern electric furnaces for vitrifying art glass (fusing process) and for mollification as well as for heat treatment of commercial-grade ceramics, glaze, and porcelain and for sintering abrasives.

Electric Furnaces for Sintering and Mollifying Glass. The modifications to currently manufactured electric furnaces for sintering and mollifying glass are indicated below.

SGO-5.5.3/8.5-I1(F) — Fig. 1. The dimensions of the glass being worked are 500 × 500 mm. The base variant of the furnace is desk-top. The dome can be opened in the manner of a suitcase cover and can be held in the open position by means of compressed-air supports. An option is a working table with a shelf on wheeled supports with a brake.

SGO-11.21.3/8.5-I1(F) — Fig. 2. The dimensions of the glass are 600 × 1100 mm. A cart with a bottom is equipped with wheeled supports with a brake. The cart can be accessed from three sides for convenient service. An additional temperature regulator with its own thermocouple is provided in the control block; this provides protection from overheating.

Fig. 1.

Fig. 2.

Fig. 3.

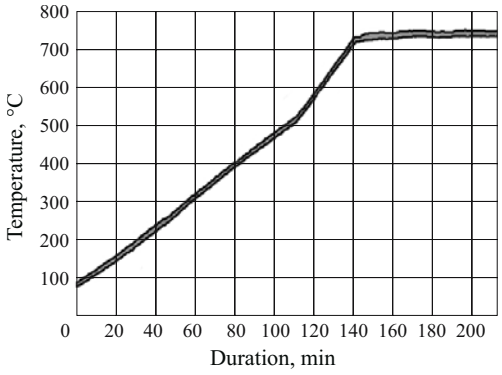

Fig. 4.

An option is an additional cart up to 450 mm deep with heating for mollification of glass.

SGO-11.21.3/8.5-I1(F) — Fig. 3. The dimensions of the glass are 1100 × 2100 mm and electromechanical drive lifts the dome in the horizontal position, holds the dome at the required height, and lowers it. There are two heating zones of dome: the first one is formed by heaters placed on the crown and the second by heaters placed in the lateral walls. A "Termodat-17E3" microprocessor two-channel programmed regulator with a physical display, allowing the operator to follow the real heating schedule, controls the temperature of the furnace. The cart can be rolled in two directions. An option is two carts, which makes it possible to increase the productivity of the furnace substantially. Double protection from overheating is provided. An option is an additional cart up to 600 mm deep with heating and an additional regulation channel for mollifying glass.

Main Structural Features and Competitive Advantages of an Electric Furnace for Fusing and Mollification Compared with Domestic and Foreign Counterparts

High degree of operational readiness: the furnace is "burned-in," the temperature regulator is set.

High-quality sintering and fusing of glass. This is achieved as follows:

uniformity of the temperatures over the entire glass surface during heating of the glass as a result of the heater power distribution on the crown and, partially, on the lateral walls of the furnace dome;

enclosed heaters — the coils are located inside ceramic or quartz tubes, which prevents clinker from falling from the coils onto the glass;

use of ceramic-fiber plates, which are manufactured in Europe and do not produce dust, for lining the dome.

Long service life and high reliability of the furnace. These qualities are obtained as follows:

lowering the specific surface power of the heaters by a factor of 2 – 3 and, in consequence, their maximum temperature;

using large-diameter wire made of resistance alloys for manufacturing heaters;

using high-quality calcined materials for thermal insulation, which do not shrink and do not form gaps during operation.

Taken together these factors increase the predicted maintenance-free service life of the furnaces to 5 years and longer.

Higher heating accuracy is achieved by smooth control of a prescribed temperature regime using a modern programmed electronic regulator and a simistor power block. The control block provides protection from short circuit currents, protection from furnace overheating, and the required indication lights.

Cost-effective electricity consumption for the fusing process is achieved by good sealing of the furnace and by using double-layer thermal insulation consisting of lightweight materials.

A modern design and high-quality fabrication are achieved using the latest equipment.

The finished electric furnaces were tested in cooperation with leading specialists from "Steklo i Stekloizdeliya" and "Steklo i Mir" manufacturing companies. This showed that the sintering of the glass is uniform and of high quality over the entire surface of the bottom. The indications of six thermocouples were recorded, using a "Termodat-26M1" 10-channel temperature meter, during the first part of the fusing process in an electric furnace with a 1100 × 2100 mm working zone. Thermocouples placed inside 5 mm thick glass samples were positioned at all characteristic points on the surface of the bottom: corners, centers of the sides, and center. Figure 4 shows the region of temperature indications from six sensors during the first part of the fusing process. The maximum heating nonuniformity over the entire period observations was ± 7.5°C.

Electric Furnace for Heat-Treatment of Ceramics. "TermIKS" manufactures electric chamber furnaces with a sliding bottom, working temperature up to 1300°C, and working-space volumes 1 and 2.5 m^3 for firing ceramics.

Lightweight refractory and fibrous materials are used in the electric furnaces. As a result, the lining accumulates relatively little heat.

The high reliability of the heating elements is due to the fact that large-diameter wires (from 6.3 to 9.0 mm) are used in them. Operating experience has shown that the service life

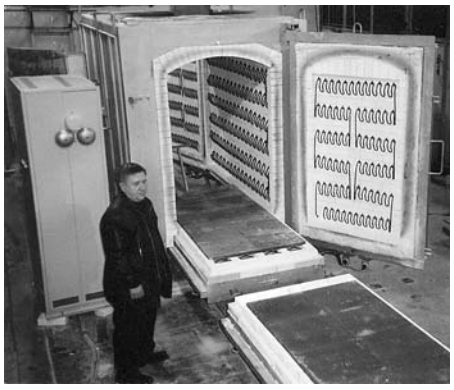

Fig. 5.

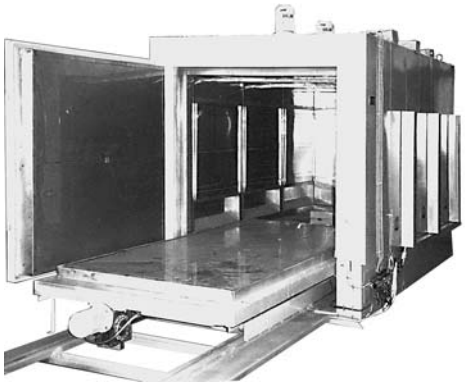

Fig. 6.

of such heaters reaches 10 years. The heaters are located on all interior surfaces of the heating chamber, with the exception of the crown.

To obtain the temperature – time heat-treatment schedule required by the technology, the system controlling the heat regime is equipped with a programmed microprocessor temperature regulator.

Figure 5 displays the ÉBP-2500/13-I1 electric furnace.

Electric chamber furnaces (including with a sliding bottom) with forced internal circulation of atmospheric air as well as an air-exchange system can be used for drying ceramic articles at temperatures up to 500°C. "TermIKS" manufactures a wide range of such furnaces with different sizes and working space volume ranging from 0.2 to 13.0 m^3.

Figure 6 displays a SDO-12.26.12/3.5-I1 convective mechanized drying electric furnace with a sliding bottom, a 3.7 m^3 working space, and three furnace fans.

In summary, the furnaces manufactured by the "TermIKS" Scientific and Manufacturing Enterprise make it possible to heat-treat articles with the lowest admissible temperature differential.